Movements and activity patterns of luderick (*Girella tricuspidata*): drivers and spatial scales

by

Gwenaël Frédéric Philippe Cadiou

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School of the Life Sciences

University of Technology Sydney

Ultimo, NSW, 2007, Australia

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

Figure 2.5 Daily mean temperature in C° (dashed line) and conductivity in mS cm^{-1} (grey line) on the left Y-axis) and daily river discharge in m^3 s^{-1} (dotted line) on the right Y-axis monitored from 1/11/2010 to 30/09/2013 in three estuaries in SE Australia in which luderick were tagged. Black diamonds indicate the date of the last detection of the fish that had left each system. GR: Georges River (tagging period: 01/02 and 01/03/2012, Fig. 2.5a); SR: Shoalhaven River (tagging periods: 06/02-16/02/2012 and 02/10/2012, Fig. 2.5b); CR: Clyde River (tagging period: 03/04-17/04/2012, Fig. 2.5c). The horizontal solid line marks the high flow threshold for each estuary.

Figure 3.1 Maps of the three estuaries studied (GR: Georges River, SR: Shoalhaven River and CR: Clyde River), showing the linear arrays of receivers, the position of data loggers, and the tagging sites.

Figure 3.2 Histograms of the daily average fish distribution along the length of the three studied estuaries.

Figure 3.3 Modal distance-to-sea (*Modal_Dist*) (a) (black line: significant simple linear regression) and linear distance (km) along the estuary containing the 50^{th} (b) and the 90^{th} (c) percentile of the kernel density distribution (KDE 50% and KDE 90%, respectively), according to the fish length (FL, mm).

Figure 3.4 Mean daily temperature in °C (dashed line) and conductivity in mS cm^{-1} (grey line) on the left Y-axis, and mean daily river flow in m^3 s^{-1} (dotted line) on the right Y-axis, between January 2011 and October 2013, for each estuary (GR: Georges River (a), SR: Shoalhaven River (b) and CR: Clyde River (c)).

Figure 3.5 Frequencies of detection of luderick (daily averages per fish) according to the temperature (°C) (a) and conductivity (mS cm^{-1}) (b) recorded by the data loggers deployed mid-water (three estuaries combined).

Figure 3.6a Mean daily temperature in °C (dashed line) and conductivity in mS cm^{-1} (grey line), and mean daily distance-to-sea on (km) of Fish #9, #10 and #13 on the left

Y-axis. Mean daily river flow in m^3 s^{-1} (dotted line) on the right Y-axis. Estuary: Georges River.

Figure 3.6b Mean daily temperature in °C (dashed line) and conductivity in mS cm^{-1} (grey line), and mean daily distance-to-sea on (km) of Fish #21, #23 and #30 on the left Y-axis. Mean daily river flow in m^3 s^{-1} (dotted line) on the right Y-axis. Estuary: Shoalhaven River. (*): fish redetected outside the tagging estuary.

Figure 3.6c Mean daily temperature in °C (dashed line) and conductivity in mS cm^{-1} (grey line) and mean daily distance-to-sea on (km) of Fish #50, #58 and #61 on the left Y-axis. Mean daily river flow in m^3 s^{-1} (dotted line) on the right Y-axis. Estuary: Clyde River. (*): fish redetected outside the tagging estuary.

Figure 4.1 Map of the study area showing the two VPS networks, the estuarine array, tagging sites and the distribution of the main habitats (seagrass, saltmarshes and mangroves).

Figure 4.2 Acceleration (top) and depth (bottom) across diel period (day and night) and tidal phase (error bars correspond to the S.E.).

Figure 4.3 Number of detections per depth categories. The fish were detected in reference to the bottom (percentage of the difference between depth obtained by the AP tags and the river bathymetry divided by the river bathymetry at the point of detection).

Figure 4.4 Fish depths expressed in percentages and divided into 4 categories (Cat 1=bottom (<10%), Cat 2=10-30%, Cat 3=30-90% and Cat 4=surface (>90%), % relative depths) across diel (day and night) and tidal (high and low) periods.

Figure 4.5 Fourier analysis of detection periodicity for activity (a) and pressure (b). (FFT based on 1024 frequencies but truncated at 205 and 512 for activity and pressure, respectively, for visualisation purposes).

GENERAL ABSTRACT

A thorough knowledge of fish movements and the factors influencing them is essential to understanding the ecology of a species, and underpins effective management actions and planning. This thesis aims to understand the movement patterns of the temperate fish species luderick (*Girella tricuspidata*), which inhabits estuaries and near coastal shallow rocky reefs of New South Wales (NSW; SE Australia) and is of high commercial and recreational fishing interest. Although the biology and ecology of this primarily herbivorous teleost fish are already documented, movements and their drivers are poorly known.

I used acoustic telemetry to address different aspects of the movements of mature luderick at various spatio-temporal scales. Using an extensive collaborative network of acoustic receivers spread along the NSW coast and in selected estuaries, I identified that large freshwater inflows resulting from heavy rainfalls were the main drivers of luderick estuarine movements: (i) they triggered fish departure from the systems and coastal migrations; (i) these events and associated changes in conductivity drove movements along estuaries; (i) and luderick decreased swimming activity and shifted in depth during high flow events.

Tagged luderick detected outside their tagging estuary (13 out 61 individuals) migrated predominantly in a northward direction, suggesting spawning migrations. Luderick travelled up to 492 km, and at speeds exceeding 57 km d^{-1}. This swimming velocity corresponds to the optimal metabolic speed estimated in laboratory experiments. Migrating luderick could visit multiple estuaries, and individuals from different estuaries converged to similar coastal areas, providing further understanding of luderick estuarine connectivity. Partial population migration may explain the inter-individual variability in estuarine residency and large-scale movements of luderick. This behaviour may provide further resilience to harvesting and changing environments.

Strong diel and sub-diel rhythms in activity were found, with luderick being more active during the day compared to the night. Luderick field metabolic rates increased from dawn and throughout the day, until they declined after dusk, which could be related to diurnal foraging activity and nocturnal sheltering behaviour.

Swimming activity decreased with temperature, and while effects of seasonality could not be fully addressed in this study, it is predicted that movement patterns of luderick would vary across seasons and years, driven by fluctuations in temperatures and rainfall regimes.

This thesis provides an understanding of luderick movement patterns and their drivers, and shows that luderick respond to changing environment by adopting a range of behavioural responses. These findings will improve the management of this species and its fishery.